

Significance of Residential Wood Smoke

Amanda Aldridge

US EPA

Office of Air Quality Planning and Standards

www.epa.gov/woodstoves



Why do we care about wood smoke?

- Benzene
- Toluene
- Aldehyde gases
- Polycyclic aromatic hydrocarbons
- Dioxin
- Particle Matter
or fine particles (PM_{2.5})



Why we care about residential wood smoke



A small community in Washington state
That's not fog - it's wood smoke

National Ambient Air Quality Standard: Particle Matter

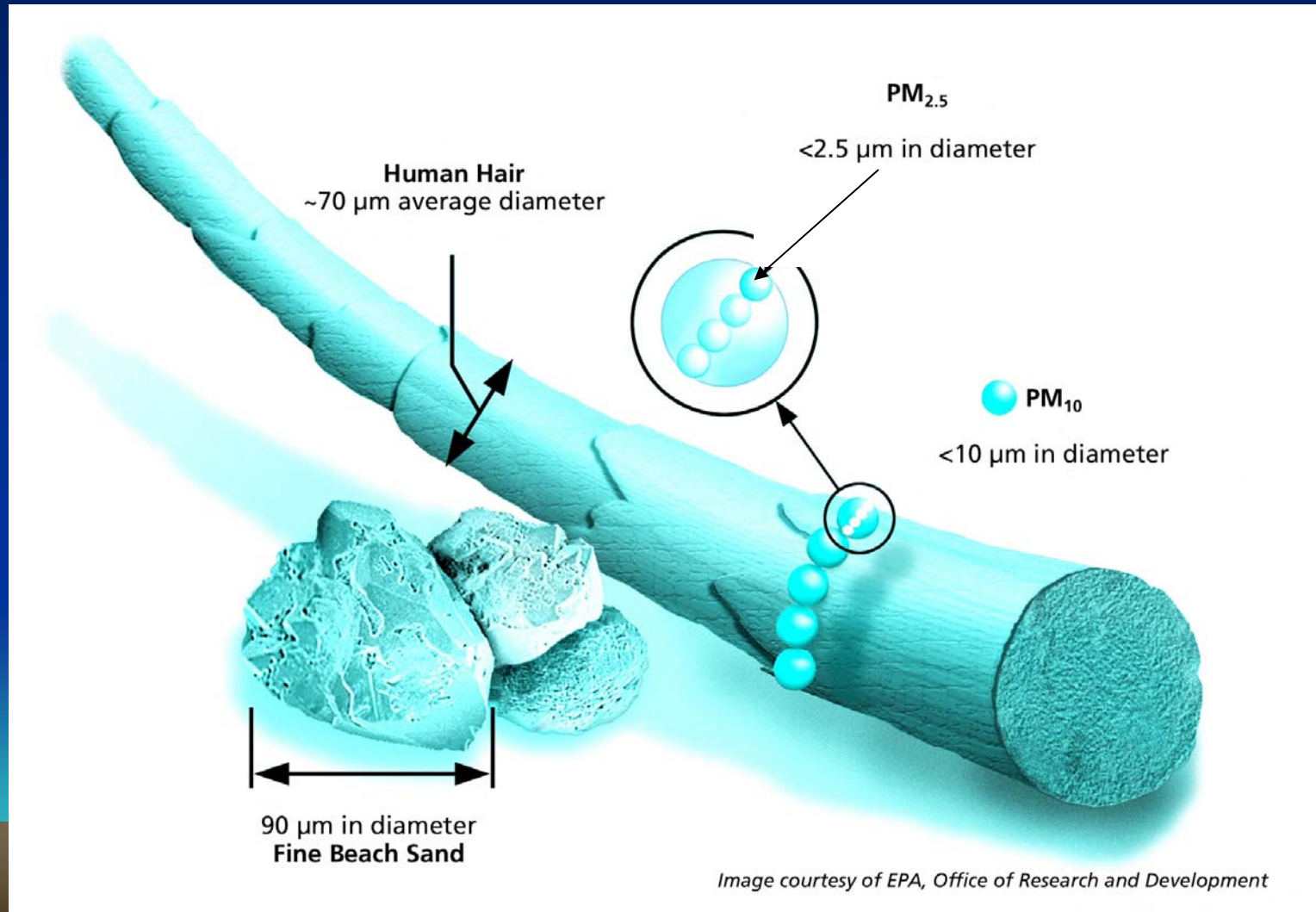
- Areas whose air quality does not meet the health-based particle matter standards are called, “nonattainment” areas
- States with non-attainment areas must submit plans, “State Implementation Plans – SIPs”
- Plans must outline how they will meet the particle matter standard

National Ambient Air Quality Standard: Particle Matter

	1997 Standards		2006 Standards	
	Annual	24-hour	Annual	24-hour
PM2.5 (Fine Particles)	15 $\mu\text{g}/\text{m}^3$	65 $\mu\text{g}/\text{m}^3$	15 $\mu\text{g}/\text{m}^3$	35 $\mu\text{g}/\text{m}^3$

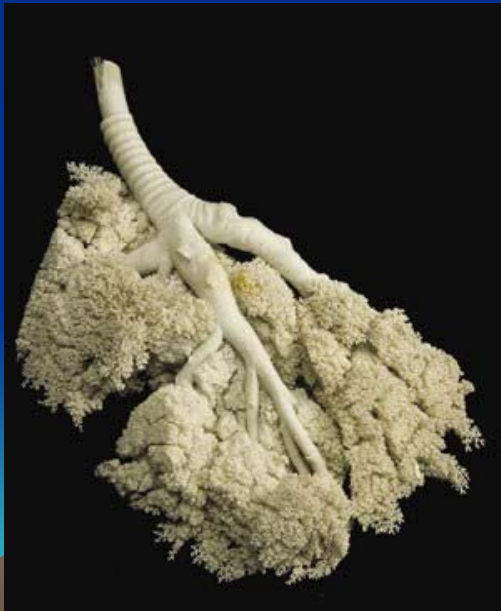
Particulate Matter: What is It?

A complex mixture of extremely small particles and liquid droplets



Particulate Matter

- Larger particles ($> PM_{10}$) deposit in the upper respiratory tract →
- Smaller, inhalable particles ($\leq PM_{10}$) → penetrate deep into the lungs



Model of interior human lung

Who's affected?

- Everyone, especially children and the elderly
- People with existing diseases such as:
 - Coronary artery disease
 - Heart failure
 - Asthma
 - Chronic bronchitis and emphysema



Woodstove Changeout Results of the Libby, Montana and Nez Perce In-Home PM_{2.5} Studies

Tony J. Ward, Ph.D.
The University of Montana



Libby Woodstove Changeout Program

Evaluate the impact of woodstove changeouts on
residential indoor $\text{PM}_{2.5}$

Woodstoves and Indoor PM

- Residential wood combustion is the largest source of ambient $\text{PM}_{2.5}$ in many Rocky Mountain communities throughout the winter months.
- Woodstoves are also a large source of indoor $\text{PM}_{2.5}$.
- This is significant because we spend the majority of our time indoors.
- Numerous studies link $\text{PM}_{2.5}$ exposure to a variety of problems, including aggravated asthma, irregular heartbeat, and premature death in people with heart or lung disease.

2006/07 Residential PM_{2.5} Sampling Program

- Sampling focused on 21 homes containing woodstoves
- 24-hour PM_{2.5} sampling
- Pre-changeout period: Oct 2006 - Nov 2006
- Post-changeout period: Dec 2006 - Feb 2007

Residential PM_{2.5} Sampling Program cont.

- Leland Sampler / Personal Environmental Monitor (PEM) with a 37-mm quartz filter:
 - Organic Carbon / Elemental Carbon (OC/EC).
 - Chemical markers of wood smoke (i.e. levoglucosan).
- DustTrak (continuous PM_{2.5}).

Residential Sampling Equipment



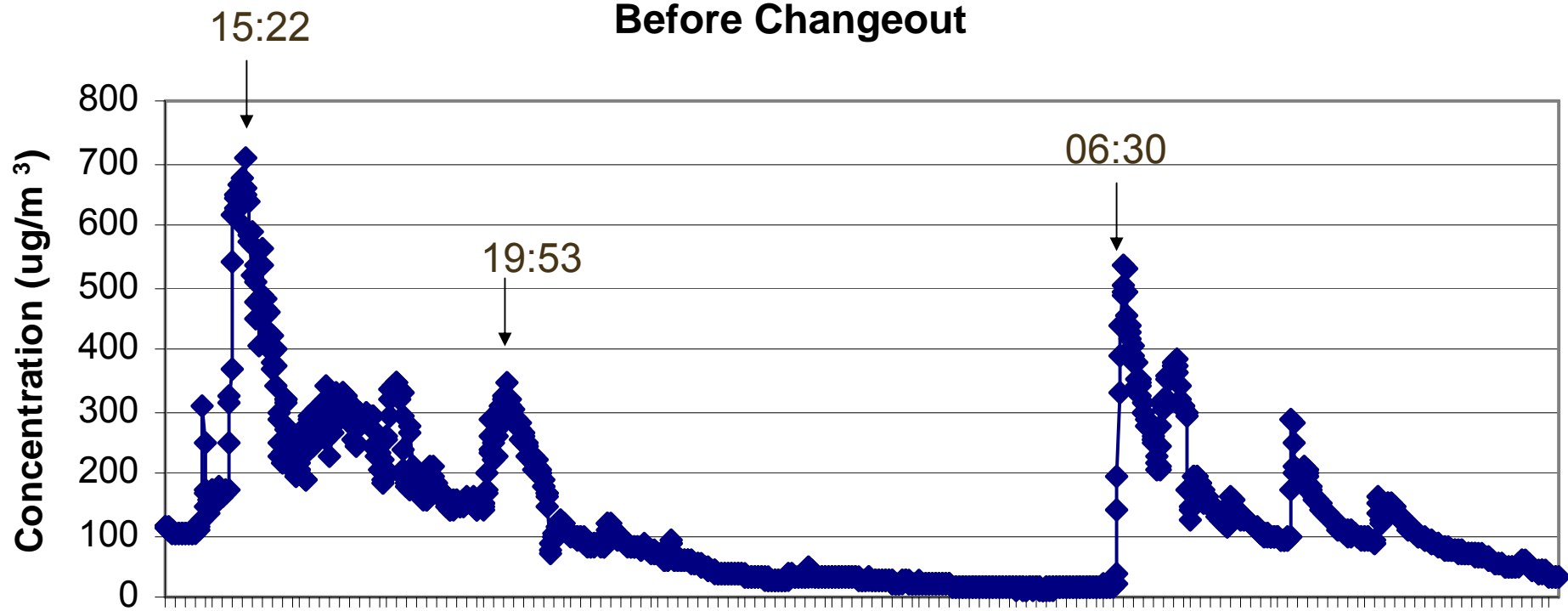
Libby Pre-Changeout PM_{2.5} Mass Results

- Avg: 53.4 $\mu\text{g}/\text{m}^3$ (35 $\mu\text{g}/\text{m}^3$ is the health based standard)
- PM_{2.5} Spikes (average was 410 $\mu\text{g}/\text{m}^3$)
- Four of the homes had spikes above 1000 $\mu\text{g}/\text{m}^3$, with maximum of 1255 $\mu\text{g}/\text{m}^3$

Libby 2006/2007 Residential PM_{2.5} Program

PM_{2.5} Mass - Home 4A

Before Changeout



Start Sampling:
10/25/06 @ 14:00

End Sampling:
10/26/06 @ 14:00

Avg = 131.8 $\mu\text{g}/\text{m}^3$

Libby Pre-Changeout PM_{2.5} Mass Results

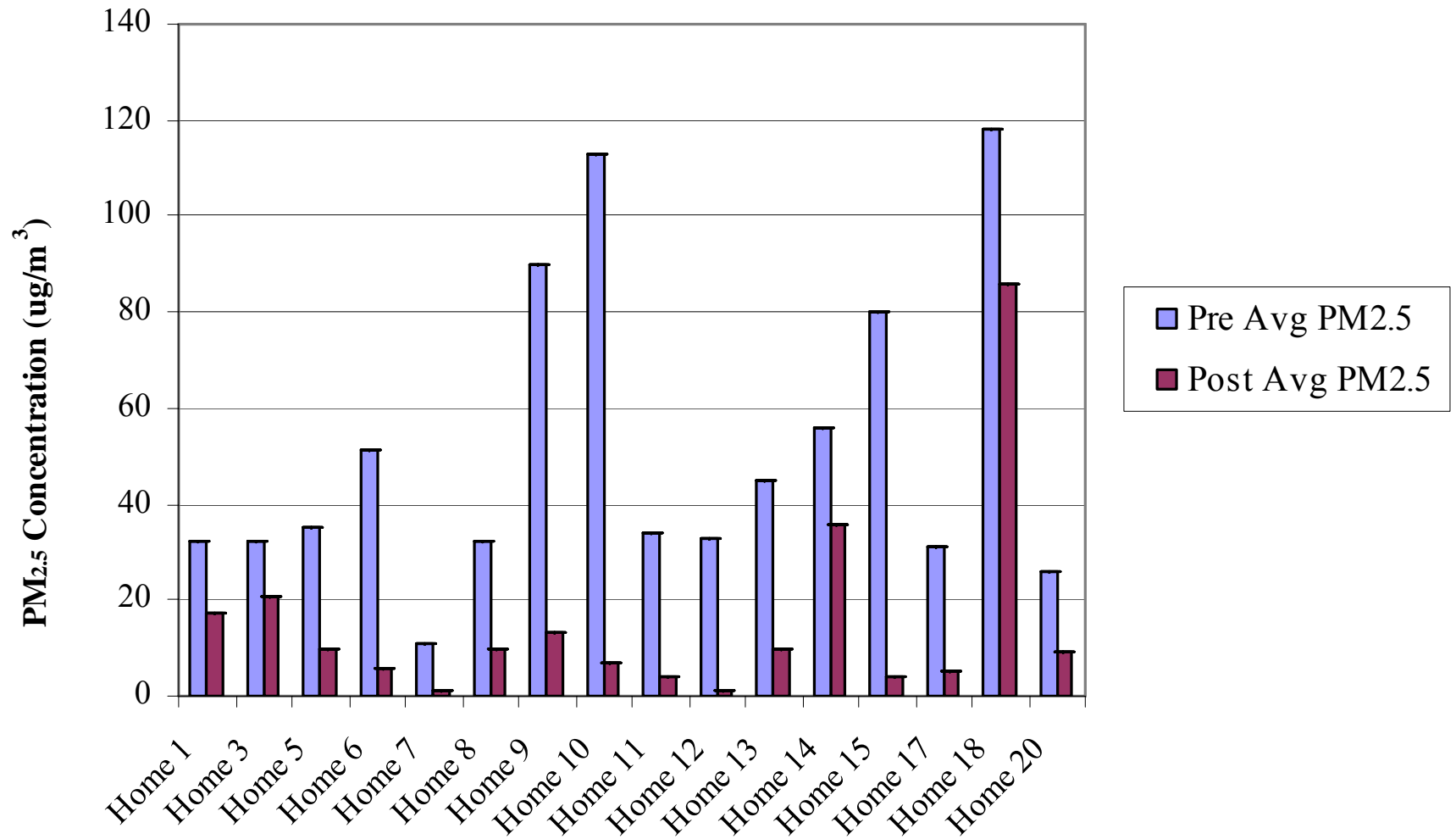
Pre-changeout average PM_{2.5} concentrations were collected within 21 homes.

Post-changeout average PM_{2.5} concentrations were collected within 16 homes.

To calculate average reductions, pre/post results were discarded for the following:

- 2A/2B: “possibly trouble getting fire lit, using new stove, chimney blocked?”
- 4A/4B: “didn’t use their new woodstove much during the 24 hours, mostly electric heat.”
- 16/16B: “went to a pellet stove”.
- 19A/19B: Residents moved.
- 21A/21B: “can't get their woodstove yet because it turns out they need a new chimney.”

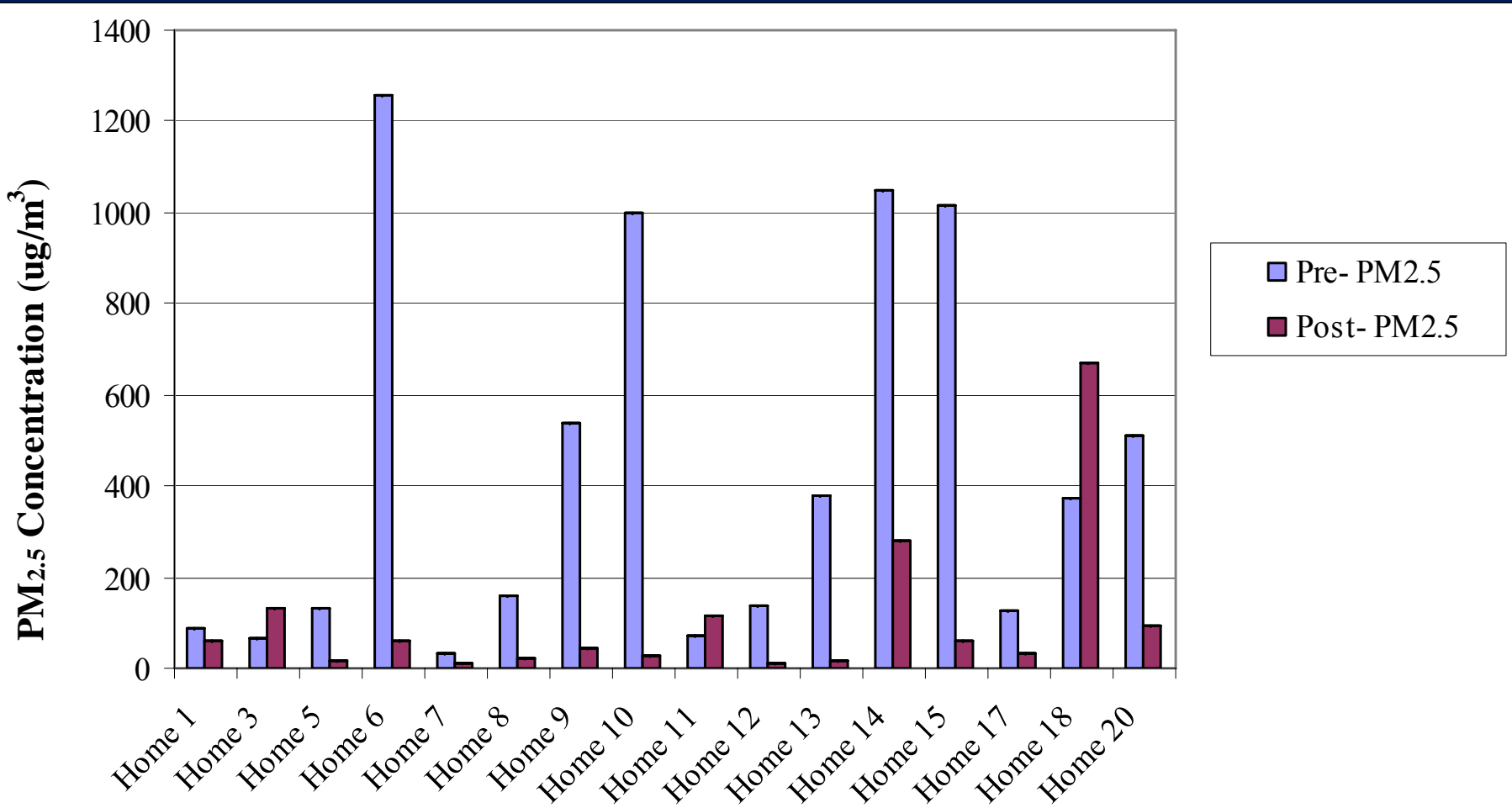
PM_{2.5} Mass Results – Pre and Post Stove Changeout



Pre-changeout avg PM_{2.5}: 53.4 µg/m³

Post-changeout avg PM_{2.5}: 15.0 µg/m³

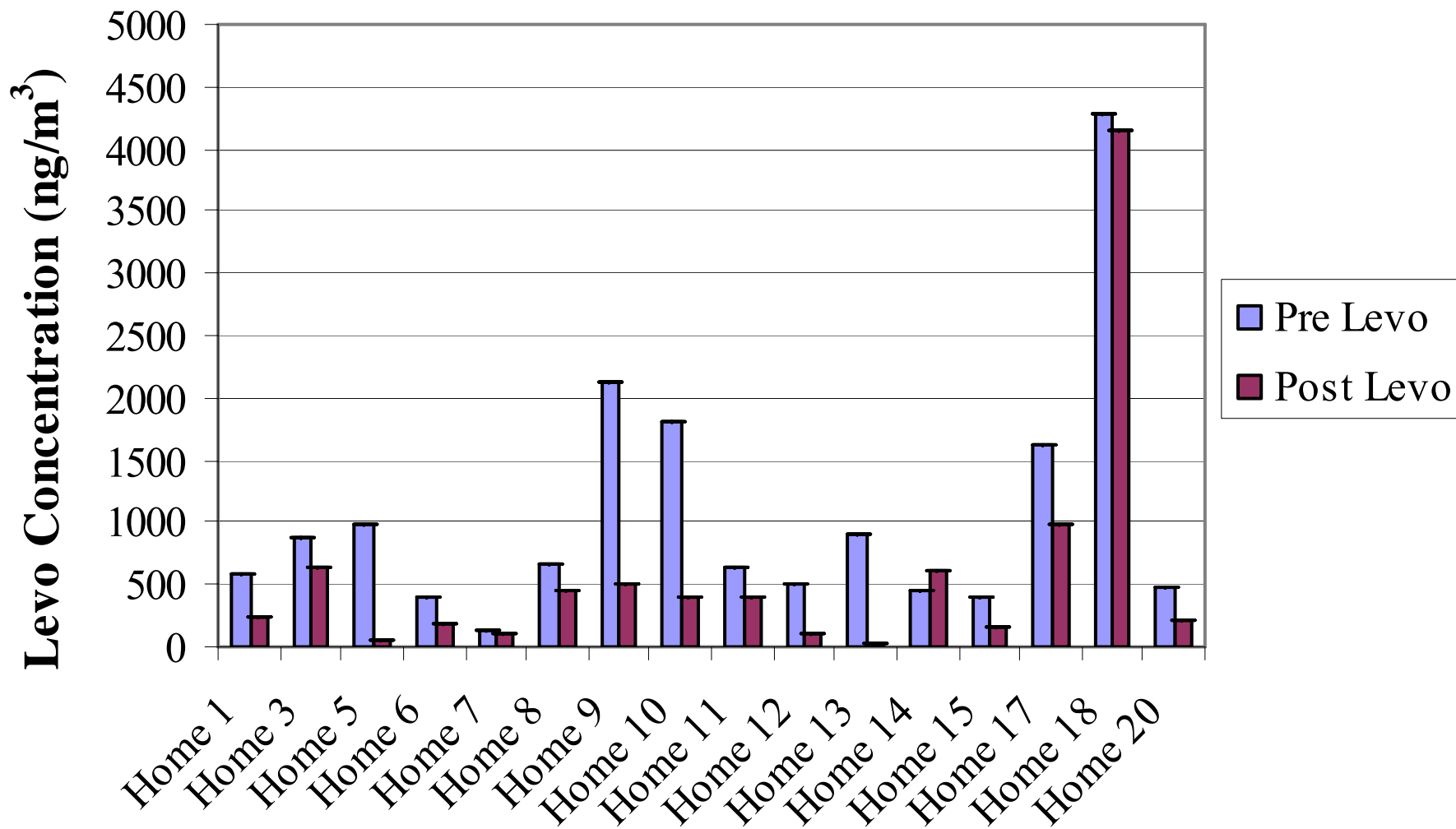
PM_{2.5} Maximum Spikes – Pre and Post Stove Changeout



Pre-changeout spike avg: 434 $\mu\text{g}/\text{m}^3$

Post-changeout spike avg: 103 $\mu\text{g}/\text{m}^3$

Levoglucosan Results



Pre-changeout avg Levo: 1049 ng/m³

2.0% PM_{2.5}, 6.0% OC

Post-changeout avg Levo: 577 ng/m³

3.8% PM_{2.5}, 4.6% OC

Results

- The average reduction in indoor PM_{2.5} as a result of wood stove changeouts within 16 homes: 72%
- Reduction of levoglucosan: 45%

Limitations/Considerations

- Only one 24-hour sampling period before and after changeout.
- Have not analyzed data with respect to weather conditions or evaluated how differences in activities (e.g., cooking, burning, etc) may have impact these observations.
- New users need practice on how to burn clean

Libby Health Impact Study – results coming soon

- Monitor changes in ambient PM_{2.5}
- Monitor changes in school indoor PM_{2.5}
- Track changes in reporting of symptoms and illness-related absences among students
- Evaluate impact of wood stove changeout on residential indoor PM_{2.5}



Univ of MT to do another study funded by NIH (\$1.2M)

- Assess improvements in quality of life and health among asthmatic children following interventions that reduce in-home wood smoke PM exposures
- Homes will receive one of these interventions:
 - Replace old stove with EPA certified stove
 - Install high efficiency particulate air (HEPA) device
 - Placebo – inactive HEPA device

Univ of MT to do another study funded by NIH (\$1.2M) con't.

- Will measure pre and post changeout:
 - Home exposure: PM_{2.5} mass, chemical wood smoke markers on filters, in urine, and exhaled breath condensate. (i.e. levoglucosan)
 - Health effects: Peak flow, frequency of asthma symptoms, frequency of rescue medication usage, healthcare utilization.

Nez Perce Program Study Overview

- Recruit households
- Conduct sampling during winter months 06/07 and 07/08 in 16 households in Kamiah and Lapwai
- Conduct woodstove changeouts in summer 2007 from the older non-EPA certified stove to a new EPA certified stove
- Measure ambient PM_{2.5} mass before and after changeout
- Measure residential indoor PM_{2.5} levels before and after woodstove changeout
- Education and outreach



Nez Perce Pre-Changeout PM_{2.5} Mass Results

Within 5 homes

Avg: 80.4 $\mu\text{g}/\text{m}^3 \pm 74.0 \mu\text{g}/\text{m}^3$

Median: 47.5 $\mu\text{g}/\text{m}^3$

PM_{2.5} Spikes - average was 924.6 $\mu\text{g}/\text{m}^3$

Maximum of 4030 $\mu\text{g}/\text{m}^3$.

Nez Perce Changeout Program Status

- Replace 11 more stoves and get pre and post changeout readings in all 16 homes this winter heating season
- Will assess health impacts: symptoms and peak flow monitoring

Acknowledgements

Lincoln County
Dept. Env. Health
Kathi Hooper
Ron Anderson
Jerry Marquez

Nez Perce Tribe
Rochelle Troyano
Julie Simpson
Johna Boulafentis
Tui Moliga
Angela Knox

Univ. of Montana, CEHS
Curtis Noonan
Kelly Crispen
Emily Weiler
Andrij Holian

Univ. of Montana, Dept. Chemistry
Chris Palmer
Megan Bergauff

Funding

Health Effects Institute (#4743-RFA04-4/06-4)

National Center for Research Resources (COBRE P20RR017670)

Hearth Patio and BBQ Association

EPA